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results of those great continental oscillations which have contributed so wonderfully to change the physical aspects of this region. The number and height of the terraces indicate extensive areas of depression and subsequent elevation.

It might here be noted that the lithological or physical features of these local deposits differ in no appreciable degree from the loess of the Missouri valley, with which it is probably synchronous, and also of the same ultimate origin. The fossils found in the loess at this point thus far, are a single spine of a fish, among the vertebrates, and among the invertebrates the following land and fresh-water shells: *Mesodon thyroides* Say, *Patula alternata* Say, *P. striatella* Anth., *Hyalina arborea* Say, *Vallonia pulchella* Müller, *Stenotrema monodon* Rack., *Helicodiscus lineatus* Say, *Strobila labyrinthica* Say, *Pupa fallax* Say, *P. armifera* Say, *P. pentadon* Say, *Helicina oculata* Say, *Succinea obliqua* Sar., *Limnophysa humilis* Say, and *Limnophysa desidiosa (?)* Say. Another species of the subgenus Patula, is, perhaps, *P. strigosa* Gould, and is represented by four specimens not well preserved. Root marks abound in some parts of the exposures. The woody matter having decayed, has left the cavity partially filled with carbonaceous material, while the mass of the concretion-like remains thus referred to vegetable origin, is strongly impregnated with the sesquioxide of iron. The presence of this oxide is in itself one of the strong reasons for regarding these remains as fragments of fossilized roots. It is not here necessary to revert to the composition of roots, for the reason that the fact of their containing a large per cent. of oxide of iron is well known. It has been thought best to record simply the finding of the loess in this vicinity, and leave to others the forming of any theories of the deposit.

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NOTES ON THE EARLY LARVAL STAGES OF THE FIDDLER CRAB, AND OF ALPHEUS.

BY A. S. PACKARD, JR.

The Zoëa of Gelasimus pugnax.—While at Fort Macon, North Carolina, in 1870, I collected a number of the common fiddler crab (*Gelasimus pugnax* Smith) with eggs. May 15th segmentation had in some just taken place, the blastoderm having formed, while in others the zoëæ were about ready to hatch, and were seen to be surrounded in the eggs by a delicate larval membrane.

For want of time the crabs bearing the eggs were placed in alcohol and studied after my return to Salem. Hoping to get another opportunity to study the living embryos and larvæ, after waiting about ten years expecting that some of our carcinologists might describe the transformations of this interesting crab, I have decided to offer the following slight contribution to the subject, with the hope that a complete history of the development of the fiddler crab may yet be worked out.

Several eggs were observed in which one, two, or sometimes three large nucleated and nucleolated (blastodermic) cells (Fig. 1, *A*) were observed lying on the periphery of the egg; they were more or less flattened, and the yolk on which they rested was hollowed out under them. When the chorion is ruptured they pass out whole as large round cells*(d)*. Their large size seems unusual for polar blastodermic cells. They all appear to be, however, waste segmentation cells. In eggs farther advanced, and after the blastoderm has appeared, the yolk is seen to be surrounded by a distinct membrane.

In the next stages observed (*B*), the zoëa, with its appendages and large, dark, sessile eyes was formed. *(C*, the same freed from the egg shell or chorion.)

Upon rupturing the egg-membrane of the alcoholic specimens, I was enabled to work out the form of the larva just before hatching. The cephalothorax is large and spherical, not segmented, while the abdomen is long and slender, and composed of six definite somites; the last one ending in a forked tail, the rounded lobes provided each with three long setæ or bristles (*D*). I could detect no frontal or dorsal spine, though they were probably present in a rudimentary form. The antennæ are as represented at Fig. 1, I, II; the upper antenna (I) is conical, short and thick, without any terminal seta; while the second or lower antenna (II) is much slenderer, rather longer, and ends in four very unequal setæ, the second seta from above being very much the larger. The mandibles are simple, and I could detect no palpus. The first maxilla (IV) is two lobed, the lobes representing two endopodites; the upper (palpus) is about half as thick as the lower, and the seta hair-like; those of the first (lower) endopodite are spine-like. Of the second maxilla (V) only the three inner lobes or endopodites were observed, the exopodites or what corresponds to the gill and scraper of the adult crab, unfortunately not having been worked out. The two maxillipeds (VI, VII) repeat each other in form; the basal joint giving rise to a simple exopodite (*ex*) and a four-jointed endopodite (*en*) in the first maxilliped, and a five-jointed one in the second. The new joints of the zoëa of the second stage and the first larval skin are to be seen in the figure.

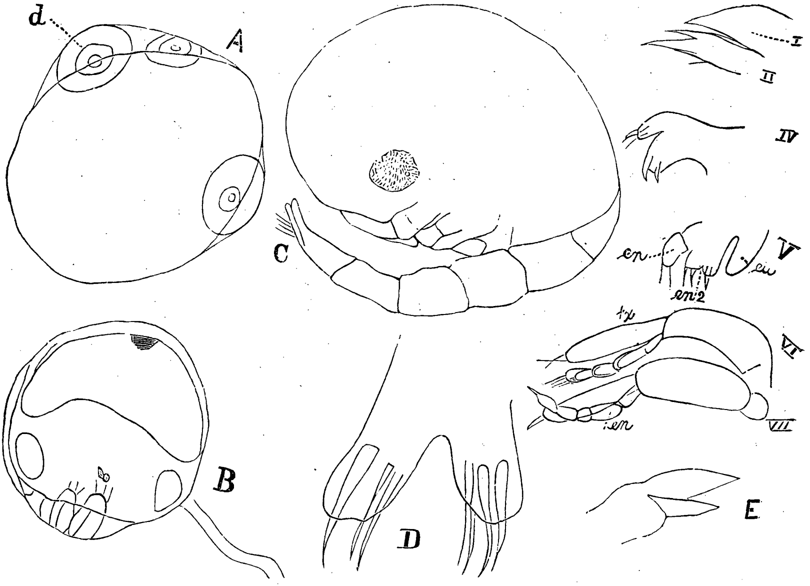

FIG. 1.—A–D, young of Fiddler Crab; E, abdominal leg of larval Alpheus.

Our knowledge of the zoëa forms of the crabs, or Brachyurous Decapoda is really quite limited, especially when we consider the first larval stage. Careful studies on the embryonic zoëa-forms only comprise those of Professor S. I. Smith and Mr. W. Faxon on the early stages of Hippa, those of Faxon and Professor Brooks on the early stages of Porcellana, and those of Faxon on the early stages of *Carcinus mænas* and *Panopæus sayi.* Now the zoëa of Porcellana, Hippa and Pagurus are, in the abdominal and other characters, quite different from those of the higher crabs, and approach those of the shrimps and other Anomura, and this is what we might expect, as these forms are intermediate between the shrimps and true crabs. It is a matter of considerable interest to learn something of the zoëa of Gelasimus, as with Ocypoda it stands at the head of the crabs, above Cancer, Carcinus, Panopæus, etc.

Comparing our Gelasimus larva, artificially removed from the egg, with Faxon's beautiful figures[1] (1, 2) of the embryonic zoëa of Carcinus shortly before hatching (his Fig. 9 representing the larva in the act of exuviating the larval skin);[2] the first antennæ are seen to be much shorter and proportionately stouter than in the remarkably developed antennæ of Carcinus, being more as in the zoëa stage; the second antennæ have nearly the same general form as in the zoëa after molting; the spine (exopodite), squamiform appendage (endopodite), and rudimentary flagellum being indicated. The antennæ of our embryo Gelasimus do not appear, then, to have the great development found by Faxon to exist in Carcinus of the same or nearly the same age. Faxon has not represented the first maxillæ, but it is two-lobed, the lower larger lobe probably being later in life differentiated into two endopodites; the second maxillæ differ from Faxon's figure of the embryonic zoëa of Panopæus in not being divided into four endopodites equal in size and form, but into three endopodites, the second (v *en*^{2}) being deeply lobed, and the third (v *en*^{3}) being two-jointed. They, however, are nearly identical in form with the second maxillæ of Cyclograpsus as figured by Müller.[3]

The endopodites of the first and second maxillipeds differ from those of Carcinus in having five joints, Carcinus having four joints to the endopodites of the first pair and only two in the second pair; in Cyclograpsus, however, Müller figures three, and as Gelasimus stands higher in the series than Cyclograpsus, it is possible that Gelasimus is, in this respect, more differentiated. (All of my drawings were made with the camera, though it is possible I may have been in error in drawing too many joints.)

The tail of our embryonic Gelasimus also shows no such extreme development as discovered in Carcinus by Faxon, and in this respect it is like Cyclograpsus (Müller's Fig. 18); and hence I am inclined to the supposition that Gelasimus before the first molt, after hatching, does not exhibit the strange and suggestive antennal and caudal features described by Mr. Faxon, and which he has interpreted so ably.[1]

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[1] On some points in the structure of the embryonic zoëa. By Walter Faxon. Bulletin Mus. Comp. Zoology, VI, No. 10. Pl. II, Fig. 1.

[2] We see no reason for not homologizing this membrane with the amnion of insects and of Limulus and Apus.

[3] See Facts for Darwin. English translation, p. 50, Fig. 18. Our Gelasimus zoëa appears to agree much more closely with the zoëa of Müller's marsh crab (Cyclograpsus) than with that of Carcinus or Panopæus, but in Müller's figure the endopodites of the second pair of maxillipeds are drawn as three-jointed. His zoëa has a dorsal and frontal spine, and represents a more advanced stage than our Gelasimus embryo.

An Abbreviated Metamorphosis in Alpheus heterochelis.—This species and *Alpheus minus* Say, are very abundant, living in the larger excurrent orifices of the large sponges which exist from the depth of one or two feet or more to deeper water, at Key West, Florida. *A. minus* is, however, far more abundant than the larger species. I found several of *A. heterochelis* with far advanced embryo, in the winter of 1869–70, and on removing the embryonic zoëa from the egg, was interested to find that the larva was of a form much more advanced than in the zoëa of other Anomoura described and figured by Fritz Müller in his suggestive work entitled " Facts for Darwin." Indeed the metamorphosis appears to be abbreviated, and the larva on hatching closely approximates the form of the adult, as in the case of the development of the lobster, the crawfish, and of *Palæmon adspersus* and *Eriphia spinifrons* (the three latter observed by Rathke). The eyes were developed on very short peduncles, being almost sessile. The embryo was near the time of hatching, though the yolk was not entirely absorbed. The two pairs of antennæ were well developed and hung down behind the large claws; the five pairs of legs were well developed, the joints distinct, and the first pair were about twice as thick as the others, the claws rather large, but not so disproportionately so as in the adult form, but as much so as in the larva in the second stage of the lobster, figured by Professor Smith. The eyes were large, but nearly sessile. The abdomen was broad and flat, spatulate at the end much as in the adult; there were five pairs of abdominal feet or swimmerets (Fig. 1 *E)*, each with an endopodite and exopodite, like those seen in the second larval stage of the lobster.

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[1] It was not until the greater part of this article was written that I saw that Mr. Faxon has raised *Gelasimus pugnax* from the egg for the express purpose of examining the embryonic cuticle, and that he has figured the forked tail of the first zoëa on his second plate, figure 11, which closely resembles that of the first stage of the zoëa of Carcinus. Had I noticed that he had studied the development of Gelasimus, I should not have attempted to write out my notes, but conclude to offer the remarks in this article subject to future corrections. Mr. Faxon does not state whether Gelasimus undergoes the sub-zoëal stage of Carcinus or not, and which our observations indicate do not probably exist. We would, in passing, suggest that the term sub-zoëa be applied to the zoëa before the amnion is thrown off, as it corresponds in a degree to the fleshy-hatched larva of the grasshoppers, myriapods and other Tracheata before the amnion is exuviated.

It thus appears that *Alpheus heterochelis* hatches in a stage more advanced than the first larval stage of the lobster. Unfortunately the specimens, though carefully preserved for several years, finally got misplaced, so that it is not possible for us to give a more detailed description of the young at the time of birth.

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REASON—A PSYCHOLOGICAL DISTINCTION.

BY HARLEY BARNES.

FROM its peculiar sphere, psychology requires a very close and rigid discrimination in the use of words. A prevalent looseness in this respect is a prolific source of confusion and misunderstanding in the discussion of this and similar questions.

An article in the August NATURALIST, entitled "The Reasoning Faculty of Animals," contains a number of interesting facts showing that the lower animals have the power of "reason;" this term is defined as "the power by means of which one proposition is deduced from another, and of forming a conclusion from known premises." This is truly the faculty of reasoning—a part of the understanding—but reason, as understood by psychologists, comprehends far more than this. The classification used in the editorial on insanity in the same number, and now generally accepted, I believe, places all mental operations in three great classes: the intellect, the emotions and the will. Continuing this division according to Hickok and others, we have the powers of the intellect arranged in three very distinct groups, called the sense, the understanding and the reason. A few words of explanation will make the arrangement plain.

Sense is the name given to that operation of the intellect which forces a constant flow of perceptions upon the field of consciousness. These may be perceptions of the five (or six) senses, internal perceptions of our own feelings and emotions, or the vague creations of a wandering judgmentless fancy common to children, savages, inebriates and opium-eaters. All these perceptions flow in an unconnected, unceasing train across the mirror of consciousness, and are as momentary as the beating of sound-waves against the tympanum. This gives occasion for the second operation of the intellect, called the *understanding*, by which these separate perceptions are placed in their proper relation to each